Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Size tailoring of aqueous germanium nanoparticle dispersions

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Ge NPs synthesis

The laser pyrolysis reactor for Ge NPs synthesis was designed such that the three axes including the laser beam pathway, gas flow pathway and view port line-of-sight crossed at a single point, as illustrated in Fig. S1.[1,2] The laser beam is focused using mirrors, a focusing lens and a window to a single point where the reaction occurs inside the reaction chamber. The flow rates of all gases were controlled by mass flow controllers. The gas flow conditions were set to 500, 15 and 2000 standard cubic centimeters per minute for GeH_4 (10 % diluted in H_2), SF_6 and He gases, respectively. The pressure of the chamber was maintained to 400 Torr. Ge NPs were collected using a membrane filter within a tightly sealed container and transferred to a N_2-filled glove box under an inert He atmosphere.

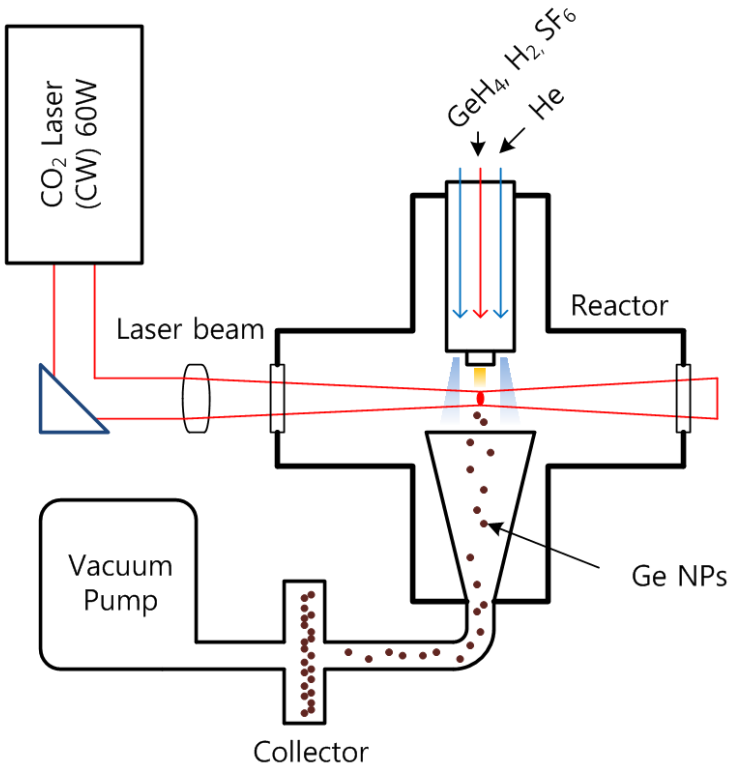

Fig. S1 Schematic of the laser pyrolysis set-up.

XRD of Ge NPs

Diffraction peaks for the (111), (220), (311), (400), (331) and (422) planes of Ge are clearly present and are consistent with previously reported X-ray diffraction data.[3,4]

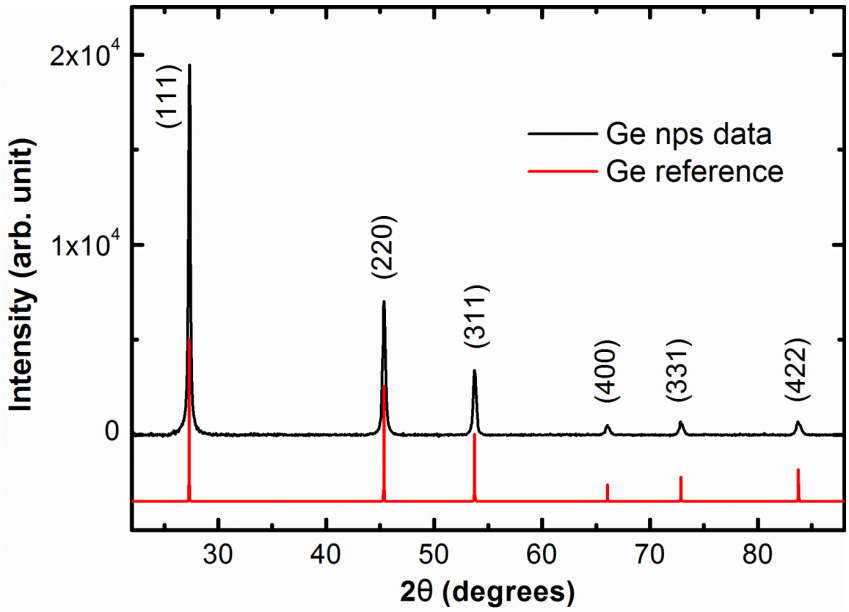

Fig. S2 X-ray diffractogram of as-produced Ge NPs.

Ge NP dispersions in various organic solvents

Fig. S3 Ge NPs dispersion in different solvents with same concentration of 10 mg ml^{-1}. From the left, solvents include dichlorobenzene, benzonitrile, toluene, deionized water, methanol, butanol, chloroform, chlorobenzene and tetrahydrofuran.

Oxidation of Ge NP dispersion in water

Fig. S4 Oxidation of Ge NP dispersions in water. The depicted vial was kept in air with the cap opened.

High resolution TEM images of Ge NPs

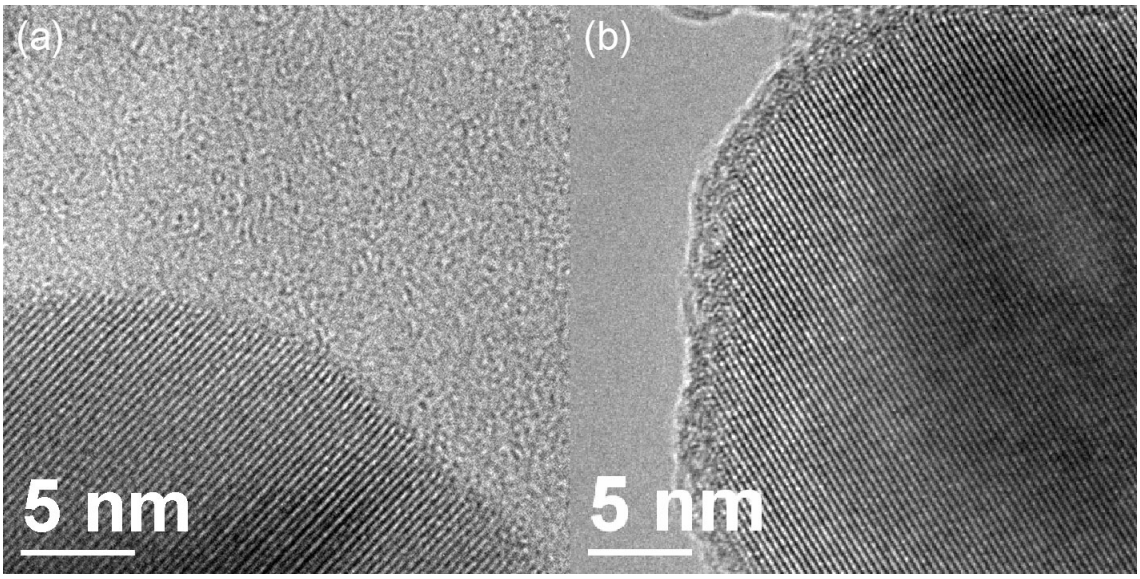

Fig. S5 High resolution TEM images of (a) as-produced Ge NPs and (b) incompletely oxidized Ge NPs aged for 2 months in water.

Fast oxidation of Ge NPs

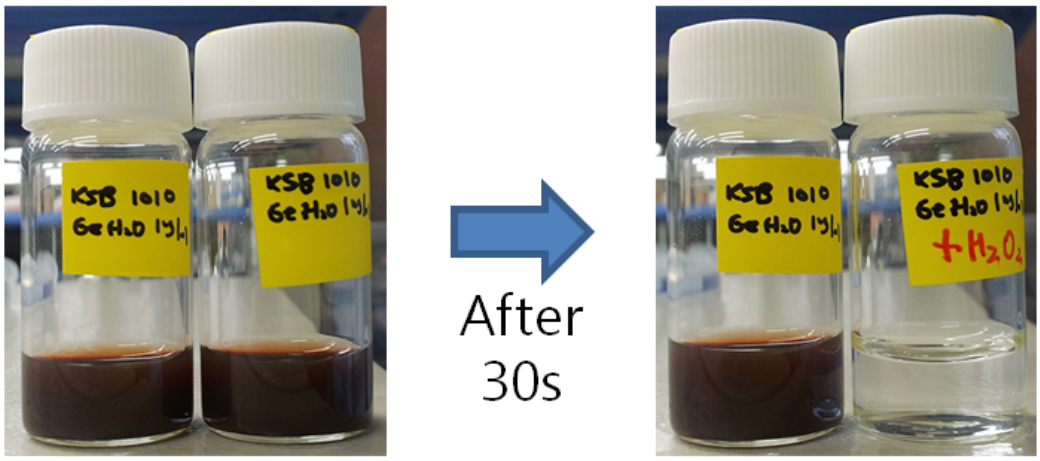

Fig. S6 Digital images illustrating the accelerated oxidation of Ge NPs using H_2O_2. Images were taken before and 30 seconds after 0.1ml of 30 wt % H_2O_2 was added to the Ge NP dispersion in water.

Absorption of Ge NPs

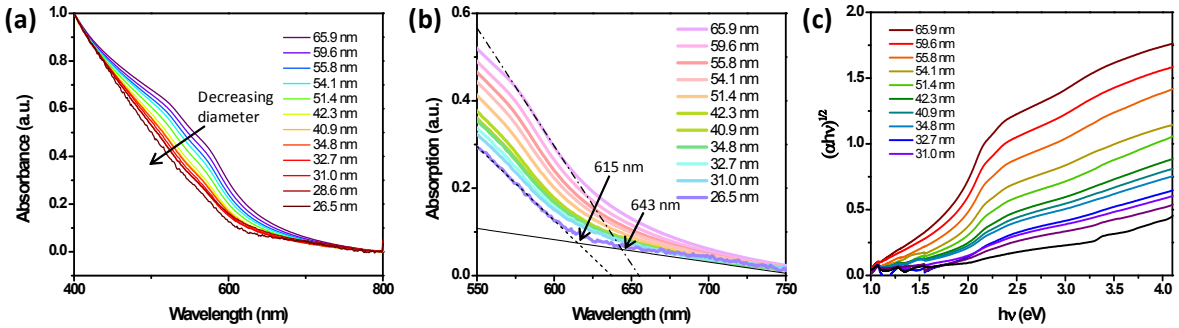

Fig. S7 Absorption spectra. (a) Normalized absorption spectra of Ge NP dispersions with different diameter. (b) Close-up of the 550 – 750 nm region showing a shift in the onset of an intense absorption band. (c) Tauc plot showing $(\alpha h\nu)^{1/2}$ vs. hν.

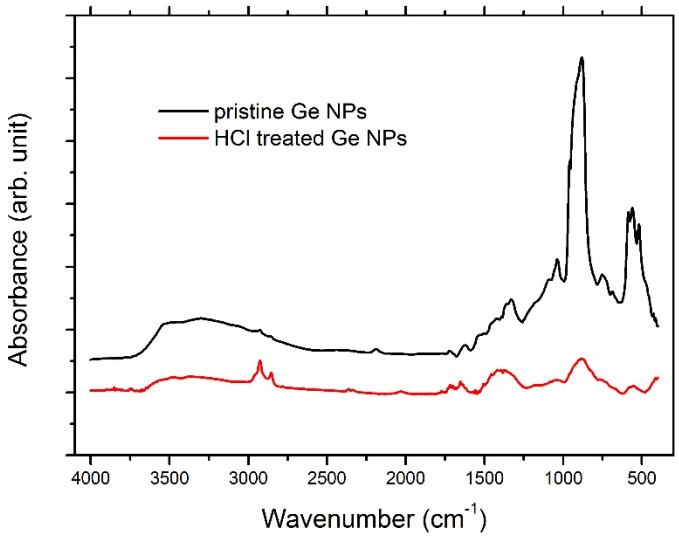

Fig. S8. Infrared absorption spectra for pristine and HCl treated Ge NPs.

Solution processed Ge thin films

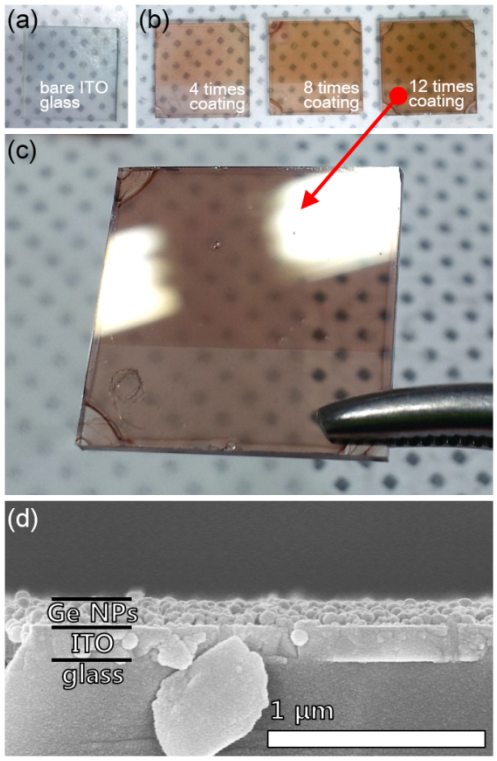

Fig. S9. Ge NP thin films. (a) Digital image of a bare glass/ITO substrate. (b) Digital images showing glass/ITO substrates with multiple coats of an aqueous Ge NP solution. (c) Close-up digitial image of a glass/ITO substrate with 12 coates of an aqueous Ge NP solution. (d) Scanning electron microscope image showing a cross-section of a Ge NP film deposited from an aqueous solution.

References

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